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Resilience: Activewear for Lower Limb Amputees who Utilize Prosthetic Limbs

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Contextual Review and Concept: This design collaboration, *Resilience*, is part of a qualitative research project that examines the activewear needs of female lower limb amputees who utilize prosthetic limbs. It is estimated that 2 million, or 1 out of 149, people are living with limb loss (upper and or lower limb amputation) in the United States alone. Roughly 185,000 limb amputations occur in the United States annually. With the number of amputations performed annually set to double by 2050, due in large part to an aging population and a projected increase in diabetes, there is a need for apparel tailored to the needs and preferences of amputees (Amputee Coalition, n.d.; Ziegler-Graham et al., 2008). The lack of such clothing creates a barrier to engagement in activities such as going to the gym and working out (Kabel, McBee-Black, & Dimka, 2016). This design concept was the outcome of a grant from Cotton Inc. that involved developing an innovative performance apparel ensemble for an underserved market using technologically enhanced cotton fabrics. Furthermore, the activewear apparel product category is essential for amputees due to the necessary physical therapy and activity needed for physical rehabilitation post-amputation which dictates the need for appropriate activewear garments. Feedback from interview participants indicated that they desired to participate in trends such as athleisure, which can be comprised of transitional apparel items, but are often not able to do so as the apparel is functionality unfit to meet their needs. From these interviews, functional and aesthetic innovations were included in the design of *Resilience* to provide our participants with an athleisure look that addresses their needs. Therefore, the purpose of this project was to provide a means in which female lower limb amputees who use prosthetic limbs have aesthetically pleasing, transitional, durable, and comfortable active apparel with ease of donning and doffing while maintaining thermal comfort, mobility, and integration of prosthetics for optimal performance and independence. This research was conducted using a user-centered design approach in which the needs of the user were central to the creation of the design (Morris, Park, & Sarkar, 2017). The designers conducted semi-structured in-depth interviews with four lower limb amputees who utilize prosthetic limbs, and two occupational therapists who assist amputees with physical rehabilitation post-amputation. Interviewing both lower limb amputees and occupational therapists provided a holistic look at amputee's activewear needs. In the interviews, lower limb amputees were asked about their functional clothing needs, notably when donning and doffing activewear, and activewear material and aesthetic preferences.

Functional Innovations: *Resilience* is a three-garment activewear ensemble with a focus on athleisure and transitional items that was created to aid with the busy lifestyle of lower limb amputees as they may have physical therapy multiple times per week while working and living a full life. These garments address the primary functional and aesthetic activewear needs of female lower limb amputees. 24-inch zippers were added to the outseam of the leggings to assist with ease of access to the prosthetic limb for donning and doffing of the legging as well as cleaning of sweat due to exercise. Furthermore, the zipper gives the wearer a choice of whether or not to show their prosthetic limb. Additionally, hidden pockets with zippers were added to the leggings to assist with securing personal items when feeling in the lower limb on the side of amputation cannot be relied on for confirmation that personal belongings are still in a pocket. Furthermore, the designers reinforced the leggings with a cushioned, durable, and batting filled knit around the area where a prosthetic limb meets the residual limb as interview findings indicated fabric tends to wear out in this area for the wearer. Furthermore, Bemis Sewfree tape was used in a majority of

the legging seams to help seams lay flat for the user's comfort. The matching jacket features a waterproof zipper for inclement weather. The back of the shirt is made of one layer with a second layer draped over it for dispersion of heat from the body. The designers created the entire look from knit fabrics comprised of 85% cotton which provides breathability and comfort for the user.

Aesthetics: The main aesthetic elements of this look are texture and a neutral color pallet; the color pallet followed the aesthetic preferences of the users interviewed. The designers intended to create activewear that follows the athleisure trend in which individual pieces of the look can be combined with existing items in the user's wardrobe, and the user could wear various pieces throughout their busy day as they transition from one activity or environment to another. The designers created visual interest by playing with line and texture. All of the garments have an emphasis on line and patchworking with multiple textures to create visual interest.

Process: Block patterns were created for a *Wolform* missy (size 10) dress form, and manipulated using flat patterning, and digital pattern manipulation using *Optitex*. Pattern manipulation included adding style lines, armscye, and neckline adjustments, adding fullness, and length adjustments. Two iterations of the leggings were created to test for seam finishing and bulk in the outseam zipper areas. The designers tested various seam samples for bulk and comfort with the final version of the leggings featuring Bemis Sewfree seam tape applied by heat press. The jacket was draped in fashion fabrics to test various fabric colors in the patchwork of the front and sleeves before final construction.

Design Contribution: *Resilience* combines user-centered design, functional problem solving, modern aesthetics, and cutting-edge seaming techniques to create functional activewear that is aesthetically pleasing, transitional, durable, and comfortable for female lower limb amputees who utilize prosthetic limbs. This design contributes to design scholarship through its application of user-centered design and designing for the differently-abled. Contrary to the majority of activewear available in the market, *Resilience* combines functionality and aesthetics to expand the possibilities and choice of activewear for amputees. This design scholarship addresses complex functionality, fit, and aesthetics problems of activewear, and particularly bifurcated garments, for lower limb amputees who utilize prosthetic limbs.

Measurements: Bust: 36.5"; Waist: 28.5"; Hip: 37.5"

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